Japanese Geotechnical Society

Japanese Geotechnical Society Standards

－Laboratory Testing Standards of Geomaterials－

－Geotechnical and Geoenvironmental Investigation Methods－

In 2014, the Japanese Geotechnical Society (JGS) began the task of translating its standards (Laboratory Testing Standards for Geomaterials and Geotechnical and Geoenvironmental Investigation Methods) into English. The English language standards will be issued in sequence in three volumes (Vol. 1 - 3).

The "Japanese Geotechnical Society Standards English Version Vol. 1" published in 2015, consists of two parts containing 26 Laboratory Testing Standards for Geomaterials and 20 Geoenvironmental Investigation Methods that are expected to be frequently used in research and professional work activities. It was very well received, in particular by overseas government organizations, with further expectations for the future.

As a result of the efforts of Ikuo Towhata, former President of JGS and members of the International Division of JGS, this volume has been presented to those involved in geotechnics in 18 countries to date, mainly in Asia. Also, more than 250 sets are already in use in Japan and elsewhere. By bringing these excellent standards of JGS to the world, this volume will contribute to the spread of technology in site investigation and laboratory testing.

Vol. 2 was also published in 2016. In Vol. 2 we have included 20 new standards for "Geotechnical and Geoenvironmental Investigation Methods" and 20 new standards for "Laboratory Testing Standards of Geomaterials". It is our wish that this volume will be widely used together with Vol. 1 in many fields in engineering practise, in education, and in research. Vol. 3 will be released in 2017.

We hope the English language versions of JGS Standards will be widely used in the many countries that have ground conditions similar to those in Japan, for ground investigation, design, construction, training of geotechnical engineers and so on.

Many donations have been received for the publication of Vol. 1 and Vol. 2, for which we would like to express our heartfelt thanks.

July 2017

Committee for the English Translation of JGS Standards

Preface

It is my great pleasure to present herein the results of the recent international activities of the Japanese Geotechnical Society (JGS). You can find here the first release of the English translation of a variety of JGS technical regulations and more will follow later. These regulations address the fundamental elements of construction practice through establishing a systematic approach from soil investigation to design analysis and performance prediction.

It is well known that the success of construction practice depends on the quality of material tests, field investigation, and design calculation that have been validated through many experiences. Those methodologies are specified by codes. In case that field investigation is carried out in a wrong way, the obtained data does not suit the design calculation. Because of the strong interdependence between practice and code, construction projects should employ both practical technologies and related codes in an assembled body. To facilitate this, JGS is now translating its codes.

As the Vice President for Asia of the International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE), the natural conditions in Asia are very difficult as exemplified by many severe natural disasters and very thick soft clay deposits in river deltas. Typhoons/cyclones provide a huge amount of precipitation in many parts of Asia and increase the amount of river sedimentation. Thus, tens of meters of very soft deposit is encountered. It is very meaningful for Asian engineers to develop a system of construction practice that suits this difficult natural conditions. The first step toward this goal is the development of a new code in which natural conditions in Asia and even past experiences are taken into account. Because the JGS codes have been developed under the natural environment in Asia, they can provide Asian engineers a starting platform for better Asian codes.

Nothing is perfect in this world. For example, many criticisms are made against uncertainties involved in Standard Penetration Tests (SPT). However, SPT provides us with specimens of subsoils for direct inspection. Moreover, many practical formulae rely on correlation with SPT data. Therefore, it is more meaningful to improve the details of SPT practice and stablish a code for SPT rather than discarding SPT as a non-standardized penetration test. Thus, it is important for all practitioners to make efforts to establish new codes. The provided JGS code can be a good starting point for this.

I would cordially invite you all to pay attention to this code to get a better scope on soil mechanics and geotechnical engineering.

Best wishes

Ikuo Towhata
Professor Emeritus of Geotechnical Engineering, University of Tokyo
Former President of the Japanese Geotechnical Society
Vice President for Asia of ISSMGE

Japanese Geotechnical Society Standards
―Laboratory Testing Standards of Geomaterials―

1 Procedure for Translating Standards into English

This document contains the laboratory test standards of the Japanese Geotechnical Society (JGS). The work of translating the standards into English is scheduled to take about 3 years from 2014. The English language standards are scheduled to be published in 3 separate volumes (Vol. 1 to Vol. 3) in order of priority of those standards most frequently used by practitioners. This is because we want to provide engineers with these Japanese laboratory standards as soon as possible to enable them to understand and refer to Japanese test equipment together with Japanese test standards. We feel that by translating into English the technical test standards that are used by Japanese engineers every day, the standards will be more meaningful tests.

The following tables show all of the laboratory test standards produced by JGS. This table of standards shows the order of publication according to the color of the standard. The standards shown in white characters against a colored background are standards that will be published in 2016 (Vol. 2). The standards with a shaded background were published in 2015 (Vol. 1), and the standards with no color will be published in the third round (Vol. 3). By publishing in English the JGS standards that are most frequently used by engineers, engineers will be able to easily refer to these test standards in the course of their work.

The Japanese Geotechnical Society has cultivated specialist engineers, scholars, and researchers for over more than 60 years. the laboratory test standards produced by the Society incorporate much of the know-how that has matured over this long period. By carrying out laboratory tests, design, and research with these standards by your side, the Japanese Geotechnical Society hopes that you will be able to contribute to the development of engineering and the economic development of your country.

2 JGS and JIS Numbers

Each of the test standards in this list is a test standard produced by the Japanese Geotechnical Society. Each standard has JGS in front of a number. The JIS that is written with each of the JGS numbers is an abbreviation for “Japanese Industrial Standard.” Japanese Industrial Standards are recognized by the Japanese Ministry of Economy, Trade and Industry of Japan and are based on the JGS standard. In these standards, each test standard number is given a JGS number and also a matching JIS number. This means that the standard produced by the Japanese Geotechnical Society is a Japanese standard. This is sufficient for users to understand. In practice either number may be used.

3 Sponsors of the Translation of the Standards into English

The English language versions of these standards have been produced through donations from Japanese construction companies, design consultants, and testing organizations. The Japanese Geotechnical Society expresses its heartfelt thanks to each company that has made a donation.

An advertisement for each company that has made a donation will be published at the end of the standards. We would be pleased if you would refer to the advertisements when using these test standards and use the advertised products and services in your work.

Table 1 List of laboratory test standards part 1

Standards published in the first round (vol.1 in 2015)

Standards published in the second round (vol.2 in 2016)

Standards published in the third round (vol.3)

Classification	Title	JGS Number	JIS Number	Vol.
Sample preparation	Practice for preparing disturbed soil samples for soil testing	JGS 0101	JIS A1201	1
	Practice for handling undisturbed samples for laboratory testing to determine mechanical properties of cohesive soils	JGS 0102		1
Classification of geomaterials	Method of classification of geomaterials for engineering purposes	JGS 0051		1
Tests for physical properties	Test method for density of soil particles	JGS 0111	JIS A1202	1
	Test method for water content of soils	JGS 0121	JIS A1203	1
	Test method for water content of soils by the microwave oven	JGS 0122		2
	Test method for water content of rocks	JGS 2134		3
	Test method for particle size distribution of soils	JGS 0131	JIS A1204	1
	Test method for particle size distribution of rock material	JGS 0132		2
	Material test method for fine fraction content of soils	JGS 0135	JIS A1223	3
	Test method for liquid limit and plastic limit of soils	JGS 0141	JIS A1205	1
	Test method for liquid limit of soils by the fall cone	JGS 0142		3
	Test method for shrinkage parameters of soils	JGS 0145	JIS A1209	3
	Test method for water retentivity of soils	JGS 0151		3
	Test method for minimum and maximum densities of sands	JGS 0161	JIS A1224	1
	Test method for minimum and maximum densities of gravels	JGS 0162		3
	Test method for frost heave prediction of soils	JGS 0171		3
	Test method for frost susceptibility of soils	JGS 0172		3
	Test method for bulk density of soils	JGS 0191	JIS A1225	1
	Method for laboratory measurement of ultrasonic wave velocity of rock by pulse test	JGS 2110		3
	Test method for axial swelling strain and axial swelling stress of rocks	JGS 2121		2
	Method for rock slaking test	JGS 2124		1
	Method for accelerated rock slaking test	JGS 2125		1
	Test method for bulk density of rocks	JGS 2132		2
Tests for chemical properties	Test method for ph of suspended soils	JGS 0211		3
	Test method for electric conductivity of suspended soils	JGS 0212		3
	Test method for ignition loss of soils	JGS 0221	JIS A1226	1
	Test method for organic carbon content of soils	JGS 0231		3
	Test method for water-soluble components of soils	JGS 0241		3
	Practice for preparing samples for identifying clay minerals in soils	JGS 0251		3
	Determination of cation exchange capacity	JGS 0261		3
Tests for permeability and consolidation properties	Test methods for permeability of saturated soils	JGS 0311	JIS A1218	1
	Test method for one-dimensional consolidation properties of soils using incremental loading	JGS 0411	JIS A1217	1
	Test method for one-dimensional consolidation properties of soils using constant rate of strain loading	JGS 0412	JIS A1227	3

Table 2 List of laboratory test standards part 2

(light grey)	Standards published in the first round (vol.1 in 2015)
(dark grey)	Standards published in the second round (vol.2 in 2016)
(white)	Standards published in the third round (vol.3)

Classification	Title	JGS Number	JIS Number	Vol.
Tests for mechanical properties	Method for unconfined compression test of soils	JGS 0511	JIS A1216	1
	Preparation of soil specimens for triaxial tests	JGS 0520		1
	Method for unconsolidated-undrained triaxial compression test on soils	JGS 0521		1
	Method for consolidated-undrained triaxial compression test on soils	JGS 0522		1
	Method for consolidated-undrained triaxial compression test on soils with pore water pressure measurements	JGS 0523		1
	Method for consolidated-drained triaxial compression test on soils	JGS 0524		1
	Method for K_0 consolidated-undrained triaxial compression test on soils with pore water pressure measurements	JGS 0525		2
	Method for K_0 consolidated-undrained triaxial extension test on soils with pore water pressure measurements	JGS 0526		2
	Method for triaxial compression test on unsaturated soils	JGS 0527		2
	Preparation of specimens of coarse granular materials for triaxial tests	JGS 0530		1
	Method for cyclic undrained triaxial test on soils	JGS 0541		2
	Method for cyclic triaxial test to determine deformation properties of geomaterials	JGS 0542		2
	Method for cyclic torsional shear test on hollow cylindrical specimens to determine deformation properties of soils	JGS 0543		3
	Practice for preparing hollow cylindrical specimens of soils for torsional shear test	JGS 0550		3
	Method for torsional shear test on hollow cylindrical specimens of soils	JGS 0551		3
	Method for consolidated constant-volume direct box shear test on soils	JGS 0560		1
	Method for consolidated constant-pressure direct box shear test on soils	JGS 0561		1
	Method for unconfined compression test on rocks	JGS 2521		1
	Method for unconsolidated-undrained triaxial compression test on rocks	JGS 2531		2
	Method for consolidated-undrained triaxial compression test on soft rocks	JGS 2532		2
	Method for consolidated-undrained triaxial compression test on soft rocks with pore water pressure measurements	JGS 2533		2
	Method for consolidated-drained triaxial compression test on rocks	JGS 2534		2
	Method for direct shear test on a rock discontinuity	JGS 2541		2
	Method for splitting tensile strength test on rocks	JGS 2551		2
Tests on stabilized soils	Test method for soil compaction using a rammer	JGS 0711	JIS A1210	1
	Test method for cone index of compacted soils	JGS 0716	JIS A1228	1
	Test method for the California bearing ratio (CBR) of soils in laboratory	JGS 0721	JIS A1211	2
	Practice for making and curing compacted stabilized soil specimens using a rammer	JGS 0811		2
	Practice for making and curing statically compacted stabilized soil specimens	JGS 0812		2
	practice for making and curing stabilized soil specimens without compaction	JGS 0821		2
	practice for making and curing chemically grouted soil specimens	JGS 0831		2
Tests on geosynthetics	Procedure for characteristic opening size test of geotextiles (wet sieving)	JGS 0911		3
	Determination of water permeability characteristics normal to the plane for geotextile and related products	JGS 0931		3
	Determination of water flow capacity in their plane for geotextile and related products	JGS 0932		3
	Direct shear test for geosynthetics	JGS 0941		3
	Pull out test of geosynthetics in soil	JGS 0942		3
Proving ring for soil testing	Standard for proving ring for soil testing	JGS 0004		3

Japanese Geotechnical Society Standard (JGS 0511-2009)
Method for unconfined compression test of soils

1 Scope

This standard specifies test methods to determine the unconfined compression strength of specimens that are self-standing without the presence of confining pressure. This standard applies mainly to undisturbed cohesive soils but can also be applied with modifications to self-standing specimens made from remolded samples, compacted soils, sandy soils, etc.

2 Normative references

The following standard shall constitute a part of this standard by virtue of being referenced herein. The latest version of this standard shall apply (including supplements).

JIS A 1203 Test method for water content of soils

3 Terms and definitions

The terms and definitions used in this standard are as follows:

3.1 Unconfined compression strength

The maximum compressive stress that the specimen can sustain under no confining pressure

4 Equipment

Test apparatus meeting the following criteria shall be used.

4.1 Unconfined compression test apparatus

The unconfined compression test apparatus shall consist of a strain-controlled compression device, pressure plates, a load cell, and a displacement gauge. The apparatus shall satisfy the following conditions (refer to Fig. 1).

a) The apparatus shall be capable of applying compressive strain to the specimen at a constant rate of movement until the strain reaches 15 % of specimen height. The working axes of the load cell, upper pressure plate, specimen, lower pressure plate, and compression device shall fall along a single line.

b) The apparatus shall be capable of measuring compressive force to an accuracy of ±1 % of the maximum compressive force applied to the specimen. The load cell shall be capable of indicating the load using a probing ring or by an electrical method. For this purpose, several load cells with different capacities between 0.2 kN and 2 kN shall be available for use according to the expected unconfined compression strength.

c) The apparatus shall be capable of measuring an amount of compression to an accuracy of ±0.1 % of the height of the specimen. The displacement gauge shall have a measurement range of 20 mm or greater and a minimum reading of 1/100 mm, or it shall be an electrical device of equal or greater performance.

4.2 Tools for specimen preparation

The tools used for specimen preparation shall be as follows (refer to Fig. 2).

a) Trimmer

b) Miter Box The miter box shall be divisible into two parts. The inner diameter shall be slightly larger than the diameter of the specimen, with the two end faces parallel and perpendicular to the axis.

c) Wire Saw and Straight edge The diameter of the steel wire used for the wire saw shall be about 0.2 mm to 0.3 mm. The straight edge shall be made of steel, single-edged, and 25 cm or longer.

4.3 Miscellaneous equipment

The following miscellaneous equipment shall be available.

a) Vernier caliper

b) Stopwatch or chronometer

c) Balance The balance shall have a sensitivity of 0.1 g.

d) Apparatus for obtaining water content The apparatus for obtaining water content shall be in accordance with JIS A 1203.

5 Specimen

5.1 Shape and dimensions of specimen

Each specimen shall be cylindrical in shape, typically with a diameter of 3.5 cm or 5.0 cm and a height 1.8 to 2.5 times the diameter. Exact specimen dimensions shall be determined according to the state of the sample material such that the test is representative of the sample.

Remark: Depending on the type of soil and the state of the sample, a sample extracted from a sampling tube may be used as a specimen by shaping the end faces and without altering the existing diameter.

5.2 Preparation of specimen

Each specimen shall be prepared according to the procedure outlined in a) to f) below. Preparation of the specimen shall be carried out quickly so as to avoid any change in the water content of the sample. Moreover, adequate care shall be exercised to avoid disturbance of the sample.

a) Any parts of the sample disturbed during the sampling process or other operations shall be removed, leaving material with a diameter and height large enough for a specimen to be prepared.

b) The side face of the specimen shall be shaped using a trimmer, wire saw, straight edge, or similar to give it a cylindrical shape with the specified diameter. If using a trimmer for shaping, care shall be exercised to avoid torsion or compressive forces on the sample. In preparing a specimen, a wire saw shall normally be used to cut the sample; however, if the sample is hard, a straight edge may be used.

c) The end faces of the specimen shall be shaped using a miter box, wire saw, straight edge, or similar so that the two end faces are parallel and perpendicular to the axis.

d) Determine the mean height, H_0 (cm), and the mean diameter, D_0 (cm), of the specimen. Use a vernier caliper or similar to measure the specimen at several places to an accuracy of 0.1 mm and then determine the mean value of each.

e) Measure the mass, m (g), of the specimen.

f) Extract a representative sample from the cut soil during the process of preparing the specimen. Obtain the water content and establish this as the water content of the specimen. If the water content of the specimen is to be obtained later by oven drying the specimen, this measurement of the cut soil may be omitted.

6 Test method

The test shall be performed using the following procedure. The test shall be started as promptly as possible after the specimen has been prepared.

a) Set up the specimen in the unconfined compression test apparatus. Place the specimen in the center of the lower pressure plate and bring the upper pressure plate into contact with the top while avoiding any compression on the specimen. Once the specimen is in place, adjust the origin of the displacement gauge and load cell.

b) Begin applying continuous compression to the specimen at a basic compressive strain rate of 1 % per minute.

c) Measure the amount of compression, ΔH (cm), and the compressive force, P (N), during compression. Measurements of compression and force shall be taken at intervals small enough to allow a smooth stress-strain curve to be drawn. Where measurements are not recorded continuously, it is recommended to measure compression at intervals of no more than 0.2 mm until compressive force reaches a maximum, and thereafter at maximum intervals of 0.5 mm.

d) Stop the compression either when the increase in strain exceeds 2 % after the point of maximum compressive force, or the compressive force reading has fallen to about 2/3 of its maximum value, or a compressive strain of 15 % has been reached.

e) Observe and record the deformed shape and failure mode of the specimen as well as other observations. Observations shall be made from the most characteristic direction of the specimen. Also, if a slip surface is found, it shall be observed from the orientation in which the steepest slope is determined. It shall be recorded such that the angle of steepest slope can be approximately read. Any heterogeneity in the specimen and the presence of foreign matter shall be observed and recorded.

7 Test results

The calculation shall be performed as follows.

a) The compressive strain of the specimen shall be calculated using the following equation.

$$\varepsilon = \frac{\Delta H}{H_0} \times 100$$

where

ε: compressive strain of specimen (%)
ΔH: amount of compression (cm)
H_0: height of specimen before compression (cm)

b) The compressive stress at compressive strain ε shall be calculated using the following equation.

$$\sigma = \frac{P}{A_0} \times \left[1 - \frac{\varepsilon}{100}\right] \times 10$$

$$A_0 = \frac{\pi D_0^{\,2}}{4}$$

where

σ: compressive stress (kN/m^2)

P: compressive force acting on specimen at compressive strain ε (N)
A_0: cross-sectional area of specimen before compression (cm^2)
D_0: diameter of specimen before compression (cm)

c) Draw a stress-strain curve with compressive strain on the horizontal axis versus compressive stress on the vertical axis.

d) Using the stress-strain curve, obtain the maximum value of compressive stress before the point where the compressive strain reaches 15 %. Establish this value as the unconfined compression strength, q_u (kN/m^2), and establish the strain at this point as the strain at failure (%). If an inflection point such as shown in Fig. 3 occurs in the initial phase of the stress-strain curve, the straight section after the inflection point shall be extended and the point at which the extended line crosses the horizontal axis shall be established as the point of origin for correction of the strain calculation.

Remark: The method used to calculate the deformation modulus, E_{50} (MN/m^2), shall be as follows.

$$E_{50} = \frac{\frac{q_u}{2}}{\varepsilon_{50}} \times \frac{1}{10}$$

where

E_{50}: deformation modulus (MN/m^2)
q_u: unconfined compression strength (kN/m^2)
ε_{50}: compressive strain (%) at compressive stress $\sigma = q_u/2$. If an inflection point such as shown in Fig. 3 is present in the initial phase of the stress-strain curve, make a correction in the same manner as in 7 d) above.

8 Reporting

The following results of the test shall be reported.

a) Diameter (cm), height (cm), mass (g), and water content (%) of the specimen

b) State of failure of the specimen

c) Stress-strain curve

d) Unconfined compression strength (kN/m^2) and strain at failure (%)

e) Other reportable matters.

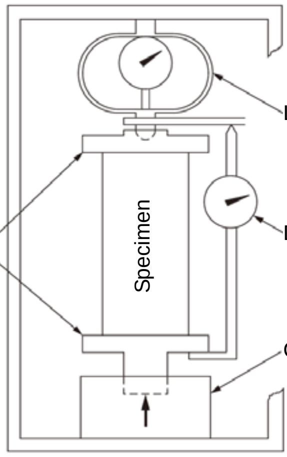
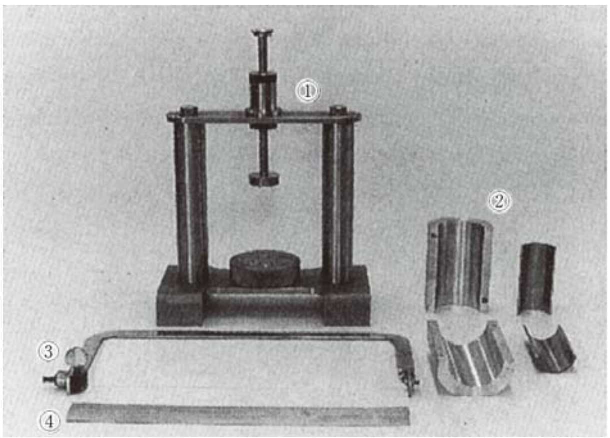


Fig. 1 Example of strain-controlled unconfined compression test apparatus



① Trimmer ③ Wire saw

② Miter box ④ Straight edge

Fig. 2 Example of tools for specimen preparation

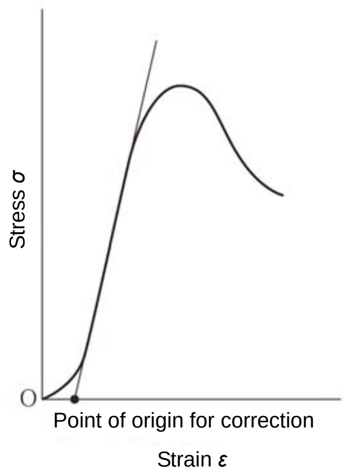


Fig. 3 Method for correction in the case of an inflection point occurring in the initial phase of the stress-strain curve

Japanese Geotechnical Society Standards
ーGeotechnical and Geoenvironmental Investigation Methodsー

1 Procedure for Translating Standards into English

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Table 1 List of geotechnical and geoenvironmental investigation standards part 1

(light grey)	Standards published in the first round (vol.1 in 2015)
(dark grey)	Standards published in the second round (vol.2 in 2016)
(white)	Standards published in the third round (vol.3)

Classification	Title	JGS Number	JIS Number	Vol.
Preliminary geotechnical investigations	Method for engineering classification of rock mass	JGS 3811		1
	Method for investigation on geometrical information of discontinuity distribution in rock mass	JGS 3821		1
Geophysical prospecting and well logging	Method for electrical logging	JGS 1121		2
Soil sampling	Method for seismic velocity logging	JGS 1122		1
	Method for obtaining soil samples using thin-walled tube sampler with fixed piston	JGS 1221		1
	Method for obtaining soil samples using rotary double-tube sampler	JGS 1222		1
	Method for obtaining soil samples using rotary triple-tube sampler	JGS 1223		1
	Method for obtaining samples using rotary double−tube sampler with sleeve	JGS 1224		2
	Method for obtaining soil block samples	JGS 1231		2
	Method for obtaining soft rock samples by rotary tube sampling	JGS 3211		2
Groundwater investigations	Method for measuring groundwater level in borehole	JGS 1311		3
	Method for measuring groundwater level in well	JGS 1312		3
	Method for measuring pore water pressure using electric transducer in borehole	JGS 1313		3
	Method for determination of hydraulic properties of aquifer in single borehole	JGS 1314		3
	Method for pumping test	JGS 1315		3
	Method for determination of hydraulic conductivity of compacted fill	JGS 1316		3
	Method for flow layer logging by tracer	JGS 1317		3
	Method for determination of hydraulic properties of rock mass using instantaneous head recovery technique in single borehole	JGS 1321		3
	Method for determination of hydraulic conductivity of rock mass using injection technique in single borehole	JGS 1322		3
	Method for lugeon test	JGS 1323		3
Sounding	Method for standard penetration test		JIS A1219	1
	Method for mechanical cone penetration test		JIS A1220	1
	Method for Swedish weight sounding test		JIS A1221	1
	Method for field vane shear test	JGS 1411		2
	Method for portable cone penetration test	JGS 1431		2
	Method for portable dynamic cone penetration test	JGS 1433		2
	Method for electric cone penetration test	JGS 1435		2
	Method for soil hardness test	JGS 1441		3
	Method for rebound hammer test on rocks	JGS 3411		3
	Method for point load test on rocks	JGS 3421		3
	Method for needle penetration test	JGS 3431		3
Loading tests	Method for plate load test on soils for road		JIS A1215	2
	Test method for the california bearing ratio (cbr) of in–situ soil		JIS A1222	2
	Method for plate load test	JGS 1521		1
	Pressuremeter test to evaluate index of the ground	JGS 1531		1
	Methods for in-situ direct shear test on rocks	JGS 3511		1
	Pressuremeter test to evaluate mechanical properties of the ground	JGS 3531		1
	Method for borehole jack test	JGS 3532		1
Site density tests	Test method for soil density by the compacted sand replacement method	JGS 1611		3
	Test method for soil density by the water replacement method	JGS 1612		3
	Test method for soil density by the sand replacement method		JIS A1214	2
	Method for measuring in-situ soil density using core cutter	JGS 1613		3
	Test method for soil density using nuclear gauge	JGS 1614		3

Table 2 List of geotechnical and geoenvironmental investigation standards part 2

(light grey)	Standards published in the first round (vol.1 in 2015)
(dark grey)	Standards published in the second round (vol.2 in 2016)
(white)	Standards published in the third round (vol.3)

Classification	Title	JGS Number	JIS Number	vol.
Site measurement of soil behaviors	Method for measuring displacement of ground surface using stakes	JGS 1711		3
	Method for measuring settlement of ground surface using settlement plate	JGS 1712		3
	Method for measuring vertical displacement of embankment using cross arm settlement gauge	JGS 1718		3
	Method for measuring tilt of ground surface using tiltmeter	JGS 1721		3
	Method for measuring displacement of the ground surface using extensometer	JGS 1725		2
	Method for measuring ground movement using strain gauge	JGS 1731		2
	Methods for measuring convergence and vertical displacement of crown in underground openings in rocks	JGS 3711		2
	Methods for monitoring rock displacements using borehole extensometers	JGS 3721		2
	Method for monitoring ground displacements using borehole inclinometer	JGS 3722		2
	Method for pull–out test of rock bolts installed in rock mass	JGS 3731		1
	Method for initial stress measurement by overcoring technique using multi–axial strain gauge	JGS 3741		1
	Method for initial stress measurement by compact conical-ended borehole overcoring technique	JGS 3751		1
Method of investigation for soil and groundwater contamination	Method for obtaining samples for environmental chemical analysis using double tube sampler with sleeve	JGS 1911		2
	Method for obtaining samples for environmental chemical analysis using direct push Method	JGS 1912		2
	Method for obtaining subsurface soil samples for environmental chemical analysis	JGS 1921		2
	Method for obtaining groundwater samples for environmental chemical analysis from monitoring well	JGS 1931		2
	Method of soil gas sampling by direct conduction for environmental chemical analysis	JGS 1941		1
	Method of active soil gas sampling for environmental chemical analysis	JGS 1942		1
	Method of passive soil gas sampling for environmental chemical analysis	JGS 1943		1
	Method for air permeability test in vadose zone	JGS 1951		3

Japanese Geotechnical Society Standard (JGS 1221-2012)
Method for obtaining soil samples using thin-walled tube sampler with fixed piston

1 Scope

This standard covers sampling of soft undisturbed clayey and sandy soils using a thin-walled tube sampler with fixed piston.

Note 1: The method is applicable for clayey soils which are soft enough to enable the sampling tube to be pushed smoothly into the ground without deformation and sandy soils which are loose and will not fall out of the sampler when raised.

Note 2: Although the objective of this standard is to obtain "A" quality samples as specified in 3.4 "Sample quality", this method should not be taken as a guarantee regarding the obtained sample quality.

2 Normative references

The following standards shall constitute a part of this standard by virtue of being referenced herein. The latest versions of these standards shall apply (including supplements).

JIMS M-1001 Rotary core boring tools

3 Terms and definitions

The terms and definitions used in this standard are as follows:

3.1 Thin-walled tube sampler with fixed piston

A sampler with fixed piston that forces the sampling tube of specified length into the ground at a continuous rate for sampling. There are two types: the hydraulic piston sampler and the extension-rod piston sampler.

3.2 Hydraulic piston sampler

A sampler in which the piston is fixed to a sampler head and the sampling tube is forced into the ground by means of hydraulic pressure.

3.3 Extension-rod piston sampler

A sampler in which a piston extension rod is used to fix the piston on the ground, while a drilling rod is used to force the sampling tube into the ground for sampling.

3.4 Sample quality

Samples shall be categorized into three levels of quality as follows.

a) Sample quality A: Samples in which none or only slight disturbance of the structure of the soils and rocks has occurred. The water content and the void ratio of the samples correspond to that in-situ. No change in constituents or the chemical composition of the soils and rocks has occurred.

b) Sample quality B: Samples in which the structure of the soils and rocks have been disturbed. However, the water content and the constituents of the samples correspond to that in-situ, and the general arrangement of the different soil layers or components can be identified.

c) Sample quality C: Samples in which the structure of the soils and rocks has been totally changed. The general arrangement of the different soil layers or components can not be accurately identified. The water content of the samples does not represent that in-situ.

4 Equipment

4.1 Drilling equipment

4.1.1 Drilling machine

A rotary boring machine able to drill down to a specified depth without disturbing the ground at the sampling location. The drilling machine also shall be able to be used to fasten the hydraulic piston sampler in place during sampling.

4.1.2 Drilling rod

A drilling rod as specified in JIMS M-1001 Rotary core boring tools with a nominal diameter of 40.5 mm or greater. The sectional drilling rod shall transfer the rotational force and feed force of the drilling machine to the bit attached to the lower end of the rod, while it also supplies drilling fluid through its hollow center to the bit during borehole drilling. The sampler shall also be fitted to the bottom end of the drilling rod. In the case of a hydraulic piston sampler, the drilling rod shall hold it in place during sampling, while in the case of an extension-rod piston sampler it is used to force the sampling tube into the ground.

4.1.3 Bit

A component with a metal or cemented carbide tip firmly welded to the end. The bit shall be attached to the bottom end of the drilling rod and drills into the ground.

4.1.4 Drilling pump

A pump used to feed and circulate the drilling fluid through the drilling rod to the bottom of the borehole.

4.1.5 Drilling fluid

A circulating fluid that is injected into the borehole to protect the borehole walls, stabilizing the borehole walls through hydraulic pressure, and removing slime from within the borehole. The drilling fluid also shall lubricate the drilling rod and cool the bit during drilling.

4.2 Hydraulic piston sampler

4.2.1 Configuration of hydraulic piston sampler

The hydraulic piston sampler shall consist of a sampler and pressurizing equipment for pushing the sampling tube into the ground.

4.2.2 Sampler

The sampler shall be made up of the following components (see Annex A).

a) Sampling tube A drawn stainless-steel pipe with an edge on one end and with sufficient rigidity to withstand the penetration force (see Annex B).

b) Sampler head A component of the sampler that attaches to the drilling rod. The outer tube and piston shall be attached to the bottom of the sampler head. The sampler head shall have a hole through which water flows from the drilling rod, pushing the sampling tube downwards into the ground.

c) Outer tube A stainless-steel pipe attached to the sampler head at its top end. The outer tube shall have a pressurized fluid release holes located that allows hydraulic pressure to be released before the sampling tube head comes into contact with the piston. The pressure release holes shall be of sufficient size to release the hydraulic pressure instantaneously.

d) Sampling tube head A head assembly to which the sampling tube is fitted. The sampling tube head shall be provided with water release hole and a locking mechanism that ensures that the piston rod can move in only one direction. The locking mechanism shall use a ball-and-cone clamp or similar devise to prevent the sampling tube being dropped when the sampler is raised. The water release hole shall be large enough to enable any water trapped within the sampling tube to be pushed out during forcing the sampling tube into the ground.

e) Piston A device consisting of a piston base provided with an air vent and packing. The piston shall be able to move smoothly, while maintaining an airtight seal between the piston and sampling tube. The air vent shall have a means of being opened from outside when disassembling the sampler after raising it, preventing negative pressure arising between the sample and the piston.

f) Piston rod A rod connecting the piston to the sampler head and holding the two components in place.

g) Pressurizing piston A piston, to the bottom end of which the sampling tube head is fitted, and that moves smoothly while maintaining an airtight seal between the outer tube and the piston rod.

4.2.3 Pressurizing equipment

A pump that is able to generate the hydraulic pressure and flow rate needed to force the sampling tube continuously into the ground.

4.3 Extension-rod piston sampler

4.3.1 Configuration of extension-rod piston sampler

The extension-rod piston sampler shall consist of a sampler, a piston extension rod, a fixing equipment and a pushing device for pushing the sampling tube into the ground.

4.3.2 Sampler

The sampler shall be made up of the following components (see Annex C).

a) Sampling tube In accordance with 4.2.2 a) "Sampling tube".

b) Sampler head A component of the sampler that attaches to the drilling rod. The sampling tube shall be fitted to its lower end. It shall be provided with a water release hole and a locking mechanism to ensure that the piston rod can move in only one direction. The locking mechanism shall use a ball-and-cone clamp or similar devise to prevent the sampling tube being dropped when the sampler is raised. The water release hole shall be large enough to enable any water trapped inside the sampling tube to be pushed out while forcing the sampling tube into the ground.

c) Piston In accordance with 4.2.2 e) "Piston".

d) Piston rod A rod that links the piston to the piston extension rod.

4.3.3 Piston extension rod

A sectional rod extending from the piston rod to the above-ground fixing equipment used to fasten the piston in place.

4.3.4 Fixing equipment

An above-ground metal fitting that holds the piston so it can not move during forcing the sampling tube into the ground (see Annex D).

4.3.5 Pushing device

A device for forcing the sampling tube continuously into the ground.

4.4 Sealing material

Material used to protect the end faces of the sample and prevent deterioration of sample quality. Paraffin with pine resin is generally used as the sealing material.

5 Sampling methods

5.1 Drilling

The drilling equipment shall be used to drill a borehole down to the sampling depth. The borehole shall have a diameter consistent with the outer diameter of the sampler to be used. Slime shall be removed from the bottom of the borehole. While removing the slime, care shall be taken so as not to disturb the ground at the sampling location.

Note : The walls of the borehole are protected by the drilling fluid, but if wall collapse is a particular concern, a casing tube shall be inserted to prevent it. When inserting the casing tube, care shall be taken so as not to disturb the ground at the sampling location.

5.2 Sampler assembly

The sampler shall be assembled after checking each of the sampler components for any imperfections.

5.3 Sampling using a hydraulic piston sampler

Sampling using a hydraulic piston sampler shall be carried out as follows.

a) Lower the assembled sampler onto the bottom of borehole, extending the drilling rod as required.

b) Measure the depth at which the sampler reaches the bottom of borehole; this depth shall be taken as the sampling start depth.

c) Fasten the drilling rod to the drilling machine.

d) Using the pressurizing equipment, apply hydraulic pressure such that the pressurized piston forces the sampling tube continuously into the ground until the hydraulic pressure is released through the pressurized fluid release hole. The penetration depth of sampling tube shall be no more than 90 cm.

e) Once the hydraulic pressure has been released through the pressurized fluid release hole, immediately raise the sampler carefully as to avoid any shocks. Do not rotate the drilling rod to cut the sample from the ground at the beginning of the raising. If resistance to the sampling tube develops while it is being forced into the ground, terminate the work and immediately raise the sampler carefully as to avoid any shocks to it.

Note: If a device is available for measuring the penetration length of the sampling tube, measure the penetration length and the depth of the bottom of the sampling tube at that time. This shall be taken as the sampling end depth.

f) Carefully remove the sampling tube from the sampler, being careful to avoid any shocks to the sample. Before removing the sampling tube from the piston, carefully open the air vent of the piston so as to avoid deforming or shocking the sample.

5.4 Sampling using an extension-rod piston sampler

Sampling using an extension-rod piston sampler shall be carried as follows.

a) Lower the assembled sampler onto the bottom of borehole, extending the drilling rod and the piston extension rod as required.

b) During lowering the sampler, fasten the piston extension rod to the drilling rod to prevent the piston from moving. When the sampler has reached the bottom of borehole, support the drilling rod with the rod holder.

c) Measure the depth at which the sampler reaches the bottom of borehole; this depth shall be taken as the sampling start depth.

d) Using the piston extension rod and the fixing equipment, fix the piston in place, preventing it from moving when the sampling tube is forced into the ground.

e) Force the sampling tube into the ground continuously by applying a load to the drilling rod using the pushing device. Measure the penetration length and the depth of the bottom of the sampling tube at that time shall be take as the sampling end depth.

f) The penetration length shall be no more than 90 % of effective length of the sampling tube (the total distance by which the piston can be retracted from the end of the sampling tube). The penetration depth shall be no more than 90 cm.

g) After measuring the sampling end depth, immediately raise the sampler carefully avoiding any shocks to it. Do not rotate the drilling rod to cut the sample from the ground at the beginning of the raising.

h) If resistance to the sampling tube develops while it is being forced into the ground, terminate the work and immediately raise the sampler carefully to avoid any shocks to it.

i) Carefully remove the sampling tube from the sampler, being careful to avoid any shocks to the sample. Before removing the sampling tube from the piston, open the air vent of the piston so carefully as to avoid deforming or shocking the sample.

6 Handling of samples

Samples shall be handled as follows.

a) Remove the slime from the upper end of the sample, then observe both end faces of the sample and measure the sample length.

b) Seal both end faces of the sample to prevent it moving within the sampling tube and to preserve sample's integrity.

c) Deliver the samples to the laboratory without delay. When transporting samples, make sure they are not subjected to impacts or vibration, or to changes in temperature due to expose to direct sunlight or the like.

d) During temporary storage of the samples on site, make sure they are not subjected to impacts or vibration, or to changes in temperature due to expose to direct sunlight or the like.

Note 1: If the sample is of sandy soil containing a small amount of fine particles, and it is judged that the quality of the sample will not be degraded by freezing and thawing, the sample may be frozen after excess water has been drained from the sample. If the sample is to be frozen, measure the weight of the sample before and after freezing, the quantity of the drainage water, and the amount of swelling along the length of the sample due to freezing. If the sample is to be frozen, there is no need to seal the end openings.

e) Note the following information on the side of the sampling tube.

1) Identification of project

2) Location number and sample number

3) Sampling start depth and end depth

Note 2: If the hydraulic piston sampler does not measure the penetration length of the sampling tube, the sampling end depth may be determined from the sampling start depth and the sample length.

4) Penetration length and sample length

5) Sampling date

7 Restoration of site

The site shall be restored as follows.

a) When samplings at all predetermined depths have been completed, fill the borehole and restore the site using appropriate methods, unless the borehole is required to be kept open for a specific purpose.

b) Implement necessary measures to ensure that no hazards are left which would be of potential harm to the public, the environment or animals.

c) Backfill the borehole using fill material. Voids shall not occur during the placement of the fill material in the borehole. Take care not to have subsequent deformation of the surrounding ground due to the backfilling.

d) If there are regulations or requirements for backfilling method, fill material, or restoration of the site; backfilling and restoration shall be in accordance with these requirements.

e) If groundwater contamination or connections between permeable layers are concerns, backfill the borehole with materials of equal or less permeability than the surrounding ground.

f) Until the borehole is finally backfilled, fence the site and cap the borehole temporarily for the safety reasons.

8 Reporting

The following items shall be reported.

a) Identification of project

b) Location number and sample number

c) Sampling start depth and end depth

d) Penetration length and sample length

Note: If the hydraulic piston sampler does not measure the penetration length of the sampling tube, the sample length only shall be reported.

e) Configuration of sampler used and sampling tube material, configuration and dimensions

f) Sampling date

g) If sample is to be frozen: weigh the sample before and after freezing, drainage quantity and amount of sample swelling due to freezing

h) If the method used deviates in any way from this standard, give details of the method used.

i) Other reportable matters

Annex A
(Reference)

Example of hydraulic piston sampler

A.1 Example of hydraulic piston sampler

Fig. A.1 shows an example of a hydraulic piston sampler.

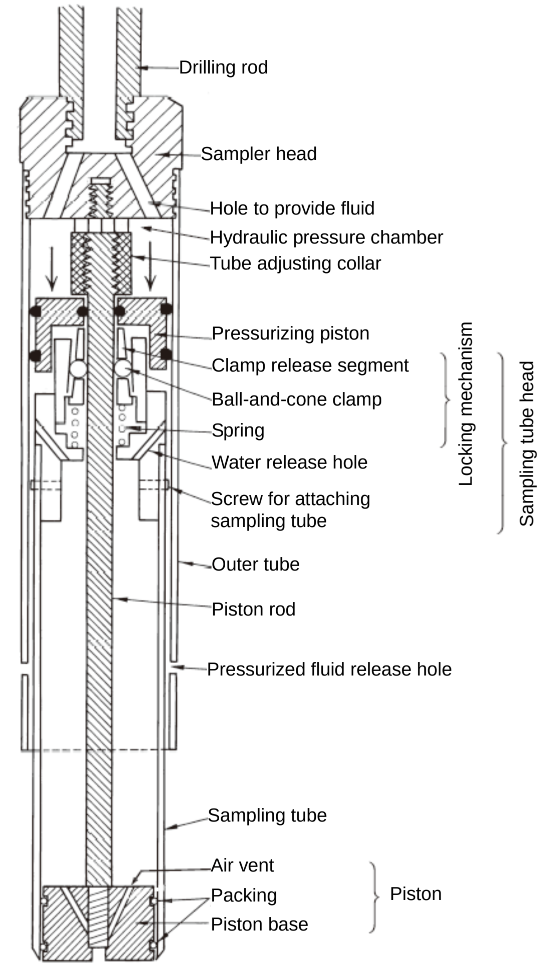

Fig. A.1 Example of hydraulic piston sampler

Annex B
(Reference)

Example of sampling tube

B.1 Example of sampling tube

Fig. B.1 and Table B.1 show an example of configuration and dimensions of a sampling tube.

Note: ISO 22475-1 states that, in general, the taper angle's edge of the sampling tube must be no greater than 5 degrees, and that edge's angle of 5 to 15 degrees may be used only in cases in which it is indicated that the quality of the sample will not be affected as a result. In Japan, the Sampling Committee of 1965-1970 (chaired by Masami Fukuoka), for establishment of the Japanese initial standard relating to thin-walled tube sampler with fixed piston (Japanese Society of Soil Mechanics and Foundation Engineering Standard JSF T-1 in 1982), reviewed all of the results of study on the effect of taper angle's edge on sample quality, also considered strength of edge and machining ability, and finally adopted an edge taper angle of 6 degrees plus and minus 1 degree, which remains in effect to this day.

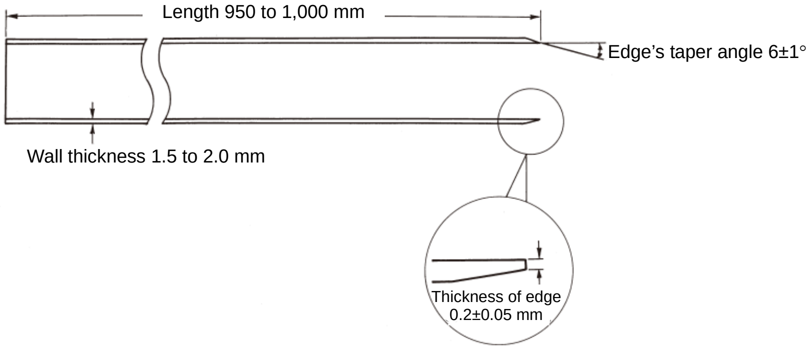

Fig. B.1 Example of sampling tube configuration

Table B.1 Example of sampling tube dimensions

Internal diameter (mm)	75.0 to 75.5
Wall thickness (mm)	1.5 to 2.0
Edge's taper angle (°)	6±1
Thickness of edge (mm)	0.2±0.05
Length (mm)	950 to 1,000
Degree of flatness (mm)	$D_{e(max)} - D_{e(min)} < 1.5$

Note: $D_{e(max)}$ and $D_{e(min)}$ are the maximum and minimum external diameter, respectively, at an arbitrary cross-section.

Annex C
(Reference)

Example of extension-rod piston sampler

C.1 Example of extension-rod piston sampler

Fig. C.1 shows an example of an extension-rod piston sampler.

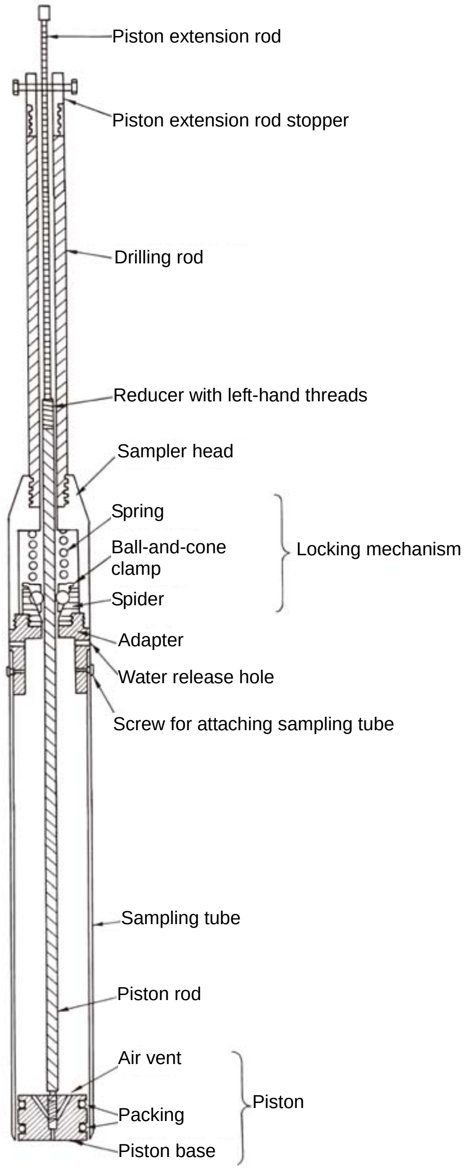

Fig. C.1 Example of extension-rod piston sampler

Annex D
(Reference)

Example of piston fixing with extension-rod piston sampler

D.1 Example of piston fixing with extension-rod piston sampler

Fig. D.1 show an example of piston fixing with extension-rod piston sampler.

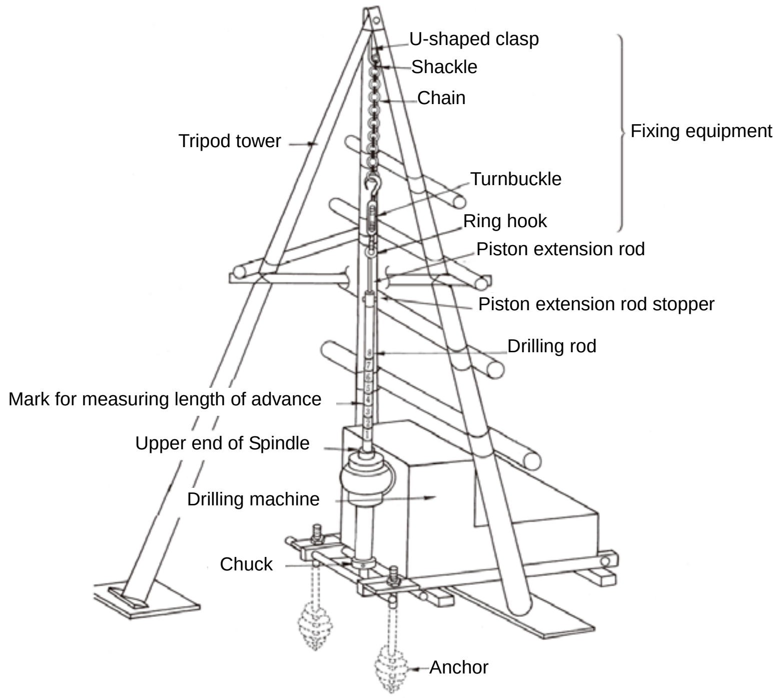

Fig. D.1 Example of piston fixing with extension-rod piston sampler